

## CLAIMS

### **What is claimed is:**

1. A method for applying a liquid finish to one or more yarns running at speeds greater than about 3000 m/min comprising the steps of:
  - a) passing the yarns into a finish applicator device while substantially blocking the entry of the air boundary layers in motion with the yarns into said finish applicator device;
  - b) contacting the yarns with a liquid finish under pressure;
  - c) substantially disengaging excess finish from the yarns; and
  - d) passing the yarns out of the applicator device.
2. The method of Claim 1 wherein at least 75 % of the cross-sectional area of the air boundary layer entrained with each yarn is blocked from entry into the applicator device.
3. The method of Claim 1 wherein the yarn speed is greater than about 5000 m/min.
4. The method of Claim 1 wherein the yarn speed is greater than about 8000 m/min.
5. The method of Claim 1 wherein the liquid finish contacts the yarn under a pressure of at least about 10 psi (68.9 kPa).
6. The method of Claim 1 wherein the liquid finish contacts the yarn under a pressure of at least about 20 psi (138 kPa).
7. The method of Claim 1 wherein the liquid finish contacts the yarn under a pressure of at least about 40 psi (276 kPa).
8. The method of Claim 1 wherein the liquid finish applied to the yarn is about 0.2 wt.% to about 5 wt.% with a coefficient of variation of about 10% or less.
9. The method of Claim 1 wherein the liquid finish applied to the yarn is about 0.4 wt.% to about 4 wt.% with a coefficient of variation of about 10% or less.

10. The method of Claim 1 wherein the liquid finish applied to the yarn is about 0.5 wt. % to about 2 wt. % with a coefficient of variation of about 10% or less.
11. A method for applying a liquid finish to yarns running at speeds greater than about 3000 m/min comprising the steps of:
  - a) passing one or more running yarns into an applicator device through a constricted yarn entry opening, individual to each yarn, in an exterior wall member and thence into a first chamber, said constricted opening substantially blocking an air boundary layer entrained by each yarn;
  - b) passing each said running yarn from said first chamber into at least one additional chamber through at least one sequential constricted opening individual to each yarn in at least one interior wall member;
  - c) positively feeding a liquid finish from an external source to at least one of said chambers traversed by each yarn;
  - d) contacting each yarn with said liquid finish under pressure;
  - e) substantially disengaging excess liquid finish from each yarn in at least one other of said chambers;
  - f) draining said excess liquid finish to an external receptor; and
  - g) passing each yarn out of the last chamber of the applicator device through a exit opening individual to each yarn in an exterior wall member.
12. The method of Claim 11 wherein at least 75 % of the cross-sectional area of the air boundary layer entrained with each yarn is blocked by the constricted yarn entry opening.
13. The method of Claim 11 wherein the yarn speed is greater than about 5000 m/min.
14. The method of Claim 11 wherein the yarn speed is greater than 8000 m/min.
15. The method of Claim 11 wherein the liquid finish contacts the yarn under a pressure of at least about 10 psi (68.9 kPa).

16. The method of Claim 11 wherein the liquid finish contacts the yarn under a pressure of at least about 20 psi (138 kPa).
17. The method of Claim 11 wherein the liquid finish contacts the yarn under a pressure of at least about 40 psi (276 kPa).
- 5 18. The method of Claim 11 wherein the liquid finish applied to the yarn is about 0.2 wt.% to about 5 wt.% with a coefficient of variation of about 10% or less.
19. The method of Claim 11 wherein the liquid finish applied to the yarn is about 0.4 wt.% to about 4 wt.% with a coefficient of variation of about  
10 10% or less.
20. The method of Claim 11 wherein the liquid finish applied to the yarn is about 0.5 wt.% to about 2 wt.% with a coefficient of variation of about 10% or less.
21. The method of Claim 11 wherein the liquid finish enters through the  
15 bottom of said chambers.
22. A method for applying a liquid finish to one or more yarns running at speeds greater than about 3000 m/min comprising the steps of:
- a) passing one or more running yarns into an finish applicator device;
  - 20 b) substantially blocking and disengaging the air boundary layer in motion with each yarn and venting it to the exterior of said finish applicator device;
  - c) contacting the yarns with a liquid finish under pressure;
  - d) substantially disengaging excess finish from the yarns; and
  - 25 e) passing the yarns out of the applicator device.
23. The method of Claim 22 wherein at least 75 % of the cross-sectional area of the air boundary layer entrained with each yarn is blocked within and vented from the applicator device.
24. The method of Claim 22 wherein the yarn speed is greater than about  
30 5000 m/min.
25. The method of Claim 22 wherein the yarn speed is greater than about 8000 m/min.

26. The method of Claim 22 wherein the liquid finish contacts the yarn under a pressure of at least about 10 psi (68.9 kPa).
27. The method of Claim 22 wherein the liquid finish contacts the yarn under a pressure of at least about 20 psi (138 kPa).
- 5 28. The method of Claim 22 wherein the liquid finish contacts the yarn under a pressure of at least about 40 psi (276 kPa).
29. The method of Claim 22 wherein the liquid finish applied to the yarn is about 0.2 wt. % to about 5 wt. % with a coefficient of variation of about 10% or less.
- 10 30. The method of Claim 22 wherein the liquid finish applied to the yarn is about 0.4 wt. % to about 4 wt. % with a coefficient of variation of about 10% or less.
31. The method of Claim 22 wherein the liquid finish applied to the yarn is about 0.5 wt. % to about 2 wt. % with a coefficient of variation of about 10% or less.
- 15 32. A method for applying a liquid finish to yarns running at speeds greater than about 3000 m/min comprising the steps of:
- a) passing one or more running yarns into an applicator device through openings individual to each yarn in an exterior wall member;
  - 20 b) passing each running yarn through a constricted passage within the applicator device;
  - c) venting the air boundary layer entrained by each running yarn to the exterior of the applicator device;
  - 25 d) impinging one or more jets of finish liquid supplied under pressure from an external source onto each running yarn within the applicator device;
  - e) passing each running yarn into two or more sequential chambers defined by one or more walls within the applicator device;
  - 30 f) draining excess finish liquid from said chambers to an external receptor; and

g) passing each yarn out of the last chamber of the applicator device.

33. The method of Claim 32 wherein least 75 % of the cross-sectional area of the air boundary layer entrained with each yarn is blocked by the constricted passage within the applicator device.
34. The method of Claim 32 wherein the venting of the air boundary layer is aided by applying suction from an exterior vacuum producing means such as a vacuum pump or aspirator.
35. The method of Claim 32 wherein the yarn speed is greater than about 5000 m/min.
36. The method of Claim 32 wherein the yarn speed is greater than 8000 m/min.
37. The method of Claim 32 wherein the liquid finish contacts the yarn under a pressure of at least about 10 psi (68.9 kPa).
38. The method of Claim 32 wherein the liquid finish contacts the yarn under a pressure of at least about 20 psi (138 kPa).
39. The method of Claim 32 wherein the liquid finish contacts the yarn under a pressure of at least about 40 psi (276 kPa).
40. The method of Claim 32 wherein the finish applied to the yarn is about 0.2 wt.% to about 6 wt.% with a coefficient of variation of about 10% or less.
41. The method of Claim 32 wherein the liquid finish applied to the yarn is about 0.4 wt.% to about 5 wt.% with a coefficient of variation of about 10% or less.
42. The method of Claim 32 wherein the liquid finish applied to the yarn is about 0.5 wt.% to about 2 wt.% with a coefficient of variation of about 10% or less.
43. A yarn finishing method comprising the steps of: applying a liquid finish to one or more yarns running at speeds greater than about 3000 m/min at a position between heated rolls on a draw panel; drying said finish during passage over said rolls; and collecting a dry drawn yarn on a winder.

44. An applicator device for applying finish liquid to one or more high speed running yarns comprising:

- a) a top portion and a bottom portion mated to the top portion;
- b) each of said top portion and said bottom portion having a front surface, a rear surface, a top surface, a bottom surface and two side surfaces;
- c) said bottom portion having entry openings in its front surface for each individual yarn and exit openings in its rear surface for each individual yarn;
- d) said yarn entry openings being of dimensions to substantially block an air boundary layer;
- e) said bottom portion having one or more interior walls dividing the bottom portion into two or more consecutive chambers;
- f) each of said interior walls in the bottom portion having constricted yarn passages, individual for each yarn, connecting the preceding and succeeding chambers;
- g) at least one of said chambers in the bottom portion communicating with external source of finish liquid;
- h) at least one of said chambers in the bottom portion communicating with an external drain;
- i) said top portion having one or more interior walls dividing the top portion into consecutive chambers corresponding in number and location to mating chambers in said bottom portion;
- j) at least one of said chambers in the top portion communicating with an external source of finish liquid; and
- k) means to hold said bottom surface of the top portion and said top surface of the bottom portion together in mated position.

45. The applicator device of Claim 44 wherein the top portion and the bottom portion are connected at one of their side surfaces by hinge means and are connected at the other of their side surfaces by quick opening clamp means.

46. The applicator device of Claim 44 wherein said yarn entry openings and said yarn passages are so constricted as to have no dimension greater than about ten times the effective yarn diameter.
47. The applicator device of Claim 44 wherein said yarn entry openings  
5 and said yarn passages are so constricted as to have no dimension greater than about six times the effective yarn diameter.
48. The applicator device of Claim 44 wherein the dimensions of said yarn entry openings are so constricted as to block at least about 75% of the cross-sectional area of the air boundary layer entrained with each yarn.
- 10 49. The applicator device of Claim 44 wherein said yarn entry openings and said yarn passages have a cross-sectional area no greater than about 0.0335 square centimeters.
50. The applicator device of Claim 44 wherein sealing means are provided between the top and bottom portion to prevent external leakage from  
15 between their mated surfaces.
51. An applicator device for applying finish liquid to one or more high speed running yarns comprising:
- a) a top portion and a sealed and mated bottom portion;
  - b) each of said top portion and said bottom portion having a front  
20 surface, a rear surface, a top surface, a bottom surface and two side surfaces;
  - c) said top portion having grooved channels in its bottom surface, individual for each yarn, extending from the front surface of the top portion to a position intermediate of the distance to the rear  
25 surface of the top portion;
  - d) said bottom portion having grooved channels in its top surface, individual for each yarn, extending from the front surface of the bottom portion to a position intermediate of the distance to the rear surface of the bottom portion;
  - 30 e) said grooved channels in the top surface of the bottom portion being aligned with the grooved channels in the mating bottom surface of the top portion;

- f) yarn entry openings formed by the intersection of said aligned grooved channels in the top and bottom portions with their respective front surfaces;
- 5 g) air boundary layer diversion ducts in said top portion communicating between each of said grooved channels and the top surface of the top portion;
- h) air boundary layer diversion ducts in said bottom portion communicating between each of said grooved channels and the bottom surface of the top portion;
- 10 i) each of said air boundary layer diversion ducts in the top portion and in the bottom portion intersecting its corresponding grooved channel in the vicinity of the respective front surfaces of the top and bottom portions forming an acute angle of about  $10^\circ$  to about  $50^\circ$  with the corresponding grooved channel, said acute angles opening outward rearward;
- 15 j) a first restriction in the dimensions of each grooved channel, said first restriction placed rearward of, and in the proximity of the intersection of the air boundary layer diversion duct with the grooved channel;
- 20 k) one or more liquid supply ducts communicating between each of said grooved channels and an external pressurized source of finish liquid, said liquid supply ducts placed rearward of said first restriction in the dimensions of each grooved channel;
- l) the terminus of each liquid supply duct at its intersection with its corresponding grooved channel being constricted so as to form a jet nozzle;
- 25 m) the terminus of each liquid supply duct at its intersection with its corresponding grooved channel forming second and subsequent restrictions in said grooved channel;
- 30 n) said bottom portion having rearward of the most rearward liquid supply duct, one or more internal walls defining two or more chambers;



- o) said chambers communicating with an external drain;
- p) an exit opening for each yarn in the rear surface of the bottom portion; and
- q) means to hold said bottom surface of the top portion and said top surface of the bottom portion together in mated position.

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52. The applicator device of Claim 51 wherein the top portion and the bottom portion are connected at one of their side surfaces by hinge means and are connected at the other of their side surfaces by quick opening clamp means.

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53. The applicator device of Claim 51 wherein the dimensions of the first restriction in the grooved channel are such as to block at least about 75% of the cross-sectional area of the air boundary layer entrained with each yarn.

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54. The applicator device of Claim 51 wherein the cross-sectional area of the second and subsequent restrictions in the grooved channel are no more than about five times the cross-sectional area of said first restriction.

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55. The applicator device of Claim 51 wherein sealing means are provided between the top portion and the bottom portion to prevent external leakage from between their mated surfaces.

56. An overfinished yarn product prepared by the process comprising the steps of:

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- a) actively applying an overfinish to a yarn at a position between heated rolls, at a yarn speed greater than about 3000 m/min at a concentration of about 0.2 wt.% to about 5 wt.%, with a coefficient of variation of concentration of 10% or less;
- b) drying said overfinish during passage over said heated rolls.